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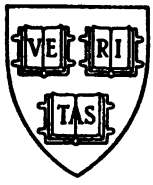

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ENGLAND AND WALES.

THE

GEOLOGY

OF THE COAST SOUTH OF

BERWICK-ON-TWEED.

(EXPLANATION OF QUARTER-SHEET 110 N.E., NEW SERIES, SHEET 2.)

BY

W. GUNN, F.G.S.

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PREFACE.

THE Map described in the present Memoir represents a small triangular piece of the extreme north of the county of Northumberland, about 14 square miles in area, lying immediately to the south of Berwick-on-Tweed, and including the coast-line from the mouth of the Tweed to Goswick. It was surveyed geologically by Mr. W. Gunn, under the supervision of Mr. H. H. Howell, and was published in 1884.

Under the whole of the district various members of the Carboniferous Limestone series extend, the thicker limestones being representatives of the Yoredale series of Yorkshire. Tolerably complete sections of these strata can be seen along the shore south of Spital, where the rocks have a general easterly dip at high angles. The area here described is contained in Sheets 4 and 7 of the 6-inch Map of Northumberland, of which MS. copies are deposited in this Office for reference.

The Geology of Berwick-on-Tweed has already been described in the "Geology of Eastern Berwickshire" (Sheet 34, Scotland), published as far back as 1864.

Mr. Gunn, who surveyed the Map, has also prepared the following brief account of it.

ARCHIBALD GEIKIE,
Director General.

Geological Survey Office,
28, Jermyn Street, London.
8th July, 1897.

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ILLUSTRATION.

Local Erosion (or Fault ?) south of Redshin - - - - 23

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THE GEOLOGY OF THE COAST SOUTH OF BERWICK-ON-TWEED.

CHAPTER I.—INTRODUCTION.

Physical Features.

The area to be described in this memoir comprises the coast from Berwick to Goswick in Northumberland, and the country inland as far as Ancroft. The highest ground, close to the high road near Spring Hill, south of Berwick, is 296 feet above the sea. From this point the ground slopes rapidly to the north and east, and more gently to the south, where there is much low-lying land. Catchlaw Crag, south of Heatherytops, is 289 feet. The 100-foot contour keeps nearly along the railway to Philadelphia, and then turns southward to Cheswick and westward to the Cat Inn and Ancroft. The alluvial flats at Goswick and Windmill Hill are not 20 feet above the sea-level. The whole area drains directly into the sea by small streams; the larger of which, Allerdean Burn and Haiden Dean Burn, unite at Ancroftsteads, and form the North Low, which enters the sea at Goswick.

Geological Description.

The rocks to be described belong wholly to the Carboniferous Limestone Series, and consist of alternations of Limestones, Sandstones, and Shales with Coals—the equivalents of the Yoredale Series and Scar Limestone of Yorkshire. They fall naturally into three divisions. The highest (*Calcareous Division*) contains all the thick limestones, and of these a fairly good section is seen along the coast. The middle portion (*Carbonaceous Division*) contains nearly all the important coal-seams, with very thin limestones, which will be elucidated by pit-sections. These two divisions were named and defined by George Tate. The lowest division (*Fell Sandstone Group*), consisting mainly of thick Sandstones with some shale, occupies only a small area about Sunnyside, in the northern corner. The general dip of the beds inland is to the S.E. or S.S.E. at angles of 10° to 15°; but near the coast they dip nearly due east at high angles, inclining to the north of east at Berwick and Spital, so that along the greater part of the coast-line, where the beds are exposed, we find them dipping as high as from 30° near Scremerston to as much as 60° at Berwick.

Boulder clay and other superficial deposits cover by far the larger portion of the area, and are everywhere based on the Carboniferous rocks.

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Table of Formations.

Post-Glacial	Blown Sand. Raised Beaches. Alluvium.
Glacial	Sand and Gravel. Boulder Clay.
Carboniferous Limestone Series.	Limestone Group, or Calcareous Division. Scremerston Coal Group, or Carbonaceous Division. Fell Sandstone Group.

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CHAPTER II.—CARBONIFEROUS.

Fell Sandstone Group.

The thick sandstones occurring below the Scremerston Coal Series have been called further south the Fell-Sandstones. We have not the whole thickness of them here, nor have we any complete section of those beds which do occur in the area and whose thickness we estimate at over 300 feet.

Sandstones and shales, with some thin coals, belonging to the higher portion of the series, were visible at one time in the lower part of the Sunnyside Cut in the road east of Tweedmouth Cemetery; but they are now nearly covered up. The dip here is about 10° to S.S.E. A coal, 4 inches thick, is visible in the top of the King's Quarry now turned into a cemetery. Massive sandstone was formerly worked here, and some is still to be seen.

A lower part of the series is seen about Tweedmouth Station, and in the cutting for the Tweedmouth Dock Railway; in old quarries near the Tower Foundry; and by the side of the Spital Road north of Tweedmouth Tower, where the sandstone is fine and white, and looks crushed. The change in the dip of the beds from S.S.E. to nearly E.N.E. can be well traced here. At low-tide sandstone can be seen in the bed of the river on the east side of Berwick Old Bridge, dipping 30°–35° to the E N.E., and the series crops out on the north side of the river along the New Walk.

There seems considerably more shale in the group at Berwick than there is further south, and we think that the character of this sandstone group is approximating to that of the group below, described in the Explanation of the adjoining sheet to the west.*

* Geology of Norham and Tweedmouth, by W. Gunn.

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CHAPTER III.—CARBONIFEROUS—*continued.*

Scremerston Coal Group, or Carbonaceous Division.*

We shall describe under this head all the beds from the Dun Limestone down to the Wester Coal—the lowest coal in the district which has been worked, or which is workable; and as the whole series has been thoroughly proved in the pit-shafts we shall be able to give sections showing the exact thickness of the different beds at various points. The general order of succession is as follows:—

	Ft.	In.
Dun Limestone.		
Coal - - - - - - 1 foot to	1	6
Sandstone and Shale, &c. - - - -	130	0
Robie's Coal - - - - - -	1	5
Sandstone and Shale, &c - - - - -	80	0
Caldside Seam, or *Fawcett Coal* - - - - 2 ft. to	2	6
Sandstone and Shale, &c. - - - - -	300	0
Scremerston Main Coal - - - - -	4	0
Sandstones and Shales &c. with *Hardy or Stony Coal* and *Diamond Seam* - - - 20 ft. to	40	0
Measures - - - - - 30 ft. to	50	0
Bulman or Cancer Coal - - - - -	6	0
Measures - - - - - - -	125	0
Three Quarter Coal - - - - 2 ft. to	3	0
Measures - - - - - - 16 ft. to	19	0
Cowper Eye Coal - - - - - -	3	6
Measures - - - - - - -	70	0
Wester Coal.		

This gives an average thickness of about 800 feet for the group.

So far as we know the Wester Coal has not been worked to much extent within this area. The Beds between the Cooper Eye Seam and the Wester Coal were exposed in making the Sunnyside Cut many years ago, but little of them is now to be seen.† We give the following account of the beds from a section of the North Road, made at the time, by the late Major Johnson of Scremerston. The section of the *Cooper Eye* Seam is

* For many particulars given in this chapter, I am much indebted to Mr. R. Nesbitt, manager of the Scremerston Coal Company, and to Mr. G. Bailes, former manager.

† Mr. N. J. Winch, in *Trans. Nat. Hist. Soc. of Northumberland and Durham*, vol. i., p. 126, says, "At the northern cut, which is now 22 feet deep, the lowest rock is dark grey encrinal limestone, covered by beds of coal measures of inconsiderable thickness, but interstratified with four thin seams of coal."

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from No. 16 Pit on the Scremerston Estate, a little west from the present working Pit, called *The New Winning.*

		Ft.	In.	Ft.	In.
Cooper Eye Seam.	*Top or Splint Coal*	1	5		
	Band stone	2	1	4	10
	Ground Coal	1	4		
	Metal	3	7		
	Limestone	1	6		
	Tills	2	0		
	Limestone (impure)	3	0		
	Grey and blue metals	3	8		
	Freestone band	1	6		
	Blue metal	7	4		
	Coal	0	3		
	Grey metal	3	0		
	Limestone	2	0		
	Blue metal	1	0		
	Freestone band	2	0		
	Coal	0	9		
	Freestone band	4	0		
	Grey metal, &c	4	10		
	Coal	0	6		
	Slaty band	4	0		
	Blue and grey metals	1	0		
	Coal	0	6		
	Limestone	0	4		
	Blue, black, and grey metals	4	8		
	Freestone	6	0		
	Grey metal	0	8		
	Limestone	0	6		
	Metal	1	4		
	Coal	0	3		
	Freestone	2	4		
	Coal	0	4		
	Blue metal	3	1		
	Limestone	1	6		
	Grey metal	0	6		
Wester Coal.	*Coal*	0	6		
	Blue metal	1	6		
	Coal	0	7		
	Grey metal	0	8		
	Coal	0	3	5	8
	Black metal	0	8		
	Coal	0	6		
	Black metal	0	6		
	Coal	0	6		
				73	7
	Blue metal	10	0		
	Slaty stone	3	0		
	Limestone	1	6		
	Blue tills	0	10		
	Coal	0	6		

As will be seen from this section there are numerous alternations of thin beds above the horizon of the Wester Coal, including several bands of limestone, and thin coal-seams.

We will now give a section showing in detail the beds from the Scremerston Main Coal down to the Cooper Eye Seam, as proved in the New Winning of the Scremerston Colliery Company at the place marked Deputy Row.

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The depth to the Scremerston Main Coal is 166 feet, including 11 seams of coal and 5 thin limestones, one of which, 1 ft. 3 ins. thick, forms the roof of the coal.

	Ft.	In.	Ft.	In.	
Black band	0	4			
Top Coal	3	0			
Band (called ground stone)	0	3			
Ground Coal	1	5½			
			5	0½	*Scremerston Main Coal.*
Soft metal	1	3			
Strong tills	1	9			
Grey freestone	15	7			
Strong blue tills	5	1½			
Hard grey freestone	0	11			
Coal	0	1			
Grey freestone	0	9			
			25	5½	
Top Coal	0	11½			
Black band	0	2¼			
Coal	1	7			
Limestone	1	1			
Coal	0	9¾			
			4	7¾	*Stony Coal Seam.*
Strong grey tills	1	5			
Coal	0	1½			
Strong grey tills	3	10			
			5	4½	
Hard Coal	0	11			
Soft grey metal	1	9¾			
Coal	1	1			
Soft grey metal	0	3¾			
Coal	0	6			
			4	7½	*Diamond Seam.*
Soft grey metal	0	4¾			
Coal	0	3			
Grey metal	2	0			
Grey freestone bands	1	5			
Strong grey freestone	1	8			
Blue metal	1	11			
Strong grey freestone	1	5			
Dark blue metal	1	4			
Strong grey freestone	0	11			
Blue metal	3	3			
Strong grey freestone	6	0			
Freestone bands	2	0			
Blue freestone	4	6			
Grey freestone	0	8			
Tills	0	4½			
Coal	0	2½			
Strong tills	2	3½			
Coal	0	1½			
Limestone	1	4½			
Black band	0	1			
Coal	0	2			
Soft blue metal	9	1			
Coal	0	4½			
Metal	0	6½			
			48	4½	

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	Ft.	In.	Ft.	In.	
Coal	1	2			
Chalk stone	0	1			
Coal	3	5			
Chalk stone	0	1			
Black band mixed with *Coal*	0	8			
			5	5	*Bullman Main Coal.*
Soft blue metal	0	6			
Limestone	2	1½			
Blue metal	1	0			
Limestone	0	3			
Blue tills	0	8½			
Limestone	0	10			
Strong tills	0	5			
Coal	0	6½			
Limestone	1	9			
Coal	0	10			
Strong black tills	2	4½			
White freestone	13	7¼			
Coal	0	9			
Black tills	0	11			
Blue metals	1	1			
Black tills	2	10			
Freestone bands	0	10			
Hard freestone	4	6			
Black tills	0	6			
Coal	1	0			
Limestone	2	5			
Black band	0	2			
Coal	0	9			
Black metal	3	7½			
Strong tills	2	6½			
Limestone	1	6			
Coal	0	9			
Blue metal	4	3			
Coal	1	3			
Limestone	1	8			
Coal bands	1	0			
Strong hard tills	1	3			
Hard grey freestone	1	0			
Strong black tills	2	0			
Grey tills	1	9			
Strong tills mixed with *Coal*	2	4			
Coal	0	3½			
Grey metal	2	9			
Black bands mixed with *Coal*	1	10			
Metal	0	8½			
Black Coaly band	0	10			
Freestone bands	1	6			
Strong tills	2	6			
Coal	0	6½			
Strong tills	0	7			
Grey freestone	13	4			
Strong grey tills	0	7			
Limestone	0	4			
Coal	0	6½			
Metal with small ironstone balls	1	1			
Strong slaty tills	3	3			
Metal with red veins like keel	0	11			
Freestone called "Ten Quarter"	10	8			
Strong tills	12	5			
			119	3½	

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	Ft.	In.	Ft.	In.	
Top Coal	0	10½			
Band	0	1½			
Coal	1	1½			
Band	0	3			
Coal	0	6½			
Limestone band	0	6			
Coal	0	7			
			4	0	*Three Quarter Coal Seam.*
Metal	1	5			
Freestone bands	2	2½			
Coal	0	2			
Metal	1	6			
Limestone	0	10			
Tills	0	6			
Coal	0	4			
Limestone, hard and brittle	0	8			
Limestone	1	6			
Coal	0	6½			
Hard tills	4	1			
Limestone	2	2			
			15	11	
Splint Coal	1	5			
Bandstone	0	11			
Ground Coal	1	3			
			3	7	*Cooper Eye Seam.*

The *Cooper Eye Coal* has been extensively worked, in fact almost entirely worked out, on the Berwick Hill ground which was drained by means of a level driven from the sea-side at Spital, in 1826. The seam varies a good deal in thickness, principally owing to the bandstone in the middle, which thickens much in places. At one of the Berwick Hill pits, nearest Heatherytops, the section was as follows:—

	Ft.	In.	Ft.	In.
Coal	1	5		
Band	2	9	5	4
Coal	1	2		

At another to the northward, near the Cow Road End the section was:—

	Ft.	In.	Ft.	In.
Coal	1	8		
Band	0	4	4	0
Coal	2	0		

The section in No. 16 Pit has already been given.

At the old Berwick Hill Pit, near Spital, the coal is said to have been wrought at a depth of 32 fathoms, and the section was as follows:—

	Ft.	In.	Ft.	In.
Top Coal			1	10
Stone	2	10 to	5	3
Bottom Coal			1	2

The New Winning Pit near Deputy Row was, in 1885, the only one working within the area of the Map.

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The *Three Quarter Coal* has been very little worked in this area. In No. 16 Pit the total thickness, including all the bands, was 8 feet 11 inches, and at Berwick Hill, Isabella Pit, its section was :—

	Ft.	In.
Coal	0	11
Band	0	1½
Coal	0	9
Band	0	1½
Coal	0	5½
Limestone	0	5½
Coal	0	6
	3	4

The outcrop of this coal will be nearly the same as that of the Cooper Eye, only about 16 feet of strata intervening. Some distance above the Three Quarter Coal comes a freestone band, called "The Ten Quarter Stone," which sometimes makes a marked feature. It is seen outside the area of this Map (in 110 N.W.) at Billylaw.

Among the beds enumerated in the section between the Three Quarter Coal and the Bulman Seam or Cancer Coal, are no less than 8 limestones and 11 thin coals. The section seems to vary a good deal, for in No. 16 Pit there are only 5 limestones and 7 coals in the same set of beds, and in the Isabella Pit only 4 limestones and 5 coals.

The total thickness between the Three Quarter and Bulman Seams varies from 119 to 141 feet. Some of the beds may be seen in the road-cutting east of Springhill. The highest beds seen are shales and thin sandstones below which come a coal and thin limestone, dipping S.S.E. at 10°. Beneath these beds comes massive false-bedded sandstone many feet in thickness.

The *Bulman* or *Cancer Coal* of Berwick becomes further south the *Main Coal* of Felkington and Ford Moss. In the Isabella Pit its section is given as follows :—

	Ft.	In.
Coal	1	8
Band	0	4
Coal, ground	2	0
	4	0

This is not like its usual character, as there are generally several thin bands called *chalk stones*. In No. 16 Pit the section of the seam is as follows :—

	Ft.	In.
Top Coal	1	1½
Chalk stone	0	0½
Splint Coal	0	9
Band stone	0	3
Ground Coal	2	0
Black metal	0	3
Chalk stone	0	1
Smithy Coal	0	4
	4	10

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It is evident that the first three members of this section represent the coal 1 foot 8 inches thick of the Isabella Pit section, the Band and Ground Coal are pretty much the same in both, and the last three members are strata not represented in Isabella Pit. The shale or metal forming the roof of this coal renders it more difficult and expensive to work than other seams, such as the Cooper Eye and Scremerston Main Coal, which have a hard limestone roof; consequently it has not been worked to so great an extent in this area.

The seam is said not to occur in the pit opposite the Cow Road End, one of the Berwick Hill Pits. This may be one of the cases where it thins away, as it does at Unthank Engine Pit in the area to the west.

The *Hardy* or *Stony Coal* and *The Diamond Coal* have been little worked in this district. We give the sections of these Coals occurring at the Isabella Pit and in No. 16 Pit:—

	Isabella Pit.	Ft.	In.	Ft.	In.	*No. 16 Pit.*	Ft.	In.	Ft.	In.
Hardy Seam	*Coal*	1	7	3	2	*Coal*	0	11	4	2
	Limestone	0	9			Band	0	2		
	Coal	0	10			*Coal*	1	3		
						Band	1	1		
						Coal	0	9		
	Shale			3	0	Strong blue metal	1	0	5	11
						Soft blue metal	0	2		
						Limestone	1	3		
						Grey tills	3	6		
Diamond Seam	*Coal*	0	9½	3	7½	*Coal*	1	0	2	8
	Shale	0	10			Band fire-clay	0	8½		
	Coal	0	10			*Coal*	0	11½		
	Shale	0	7							
	Coal	0	7							

In No. 16 Pit the Hardy Seam is only separated from the Scremerston Main Coal by 5½ feet of measures, while at the New Winning these coals are 25½ feet apart; a sandstone, 15 feet 7 inches thick, being one of the beds intervening.

The workings in the *Scremerston Main Coal* are of very old date, and the coal was drained by a water-level from the sea-side at Hudshead Shiel, which, like the old Spital level, was in existence in the year 1764. This seam is certainly the best of the series in this neighbourhood and is the only one in North Northumberland that has been won by means of a very deep shaft. We give below the section of Jack Tar Pit, Scremerston Colliery, the deepest pit in North Northumberland.

Section of the Jack Tar Pit, Scremerston.

	Ft.	In.	Ft.	In.
1. Soil	1	0		
2. Clay	3	0		
3. Soft brown freestone	3	10		
4. Blue metal	10	8		
5. Limestone (Woodend)	7	0		
			25	6

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	Ft.	In.	Ft.	In.
6. Blue Metal	14	0		
7. *Coal*	0	6		
8. White metal	8	0		
9. White freestone	4	0		
10. Blue metal bands	1	0		
11. Blue metal	0	6		
12. *Coal*	0	6		
13. White freestone	5	0		
14. Freestone bands	2	0		
15. Tills	4	6		
16. Freestone bands	2	0		
17. *Coal*	1	8		
			43	8
18. White freestone	5	4		
19. Freestone	2	0		
20. Blue metal	5	1		
21. *Coal*	0	2		
22. Soft grey freestone	3	3		
23. White freestone	11	4		
24. Freestone bands	9	0		
25. Hard tills	21	0		
26. Limestone (Dunstone)	7	0		
27. *Coal*	1	2		
			65	4
28. White metal	4	4		
29. Hard freestone	8	2		
30. White metal	3	0		
31. Freestone and tills	35	0		
32. Soft white freestone	83	6		
33. *Coal* (Robie's)	1	5		
			135	5
34. Metal and freestone bands	18	0		
35. Soft black metal	0	6		
36. Soft blue metal	12	3		
37. Soft light blue metal	8	6		
38. Blue metal	3	10		
39. Hard blue metal	3	6		
40. White freestone	5	3		
41. White hard freestone	12	9		
42. Blue metal	6	0		
43. Bastard blue metal	7	2		
44. *Coal* (*Caldside Seam*)	0	8		
			78	5
45. Dark brown metal	1	4		
46. Hard freestone	0	11		
47. Blue metal	1	9		
48. Hard white freestone	3	0		
49. Blue metal	1	6		
50. Hard white freestone	0	8		
51. Blue metal	5	6		
52. *Coal*	0	3		
53. Soft light blue metal	10	2		
54. Hard freestone band	0	5		
55. Soft light blue metal	0	7		
56. Hard brown stone	2	2		
57. Hard blue metal	2	3		
58. Soft blue do.	2	1		
59. Hard flinty girdles	1	9		
60. Soft blue metal	3	1		
61. Dark blue metal	9	1		
62. Soft blue do.	1	9		
63. Red freestone	14	7		
64. Soft blue metal	0	11		

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	Ft.	In.	Ft.	In.
65. *Coal*	0	2		
66. Dark grey whin	0	3½		
67. Soft blue metal	4	7		
68. Soft light blue metal	5	2		
69. Hard do.	3	11		
70. Soft do.	14	1½		
71. Limestone	1	2		
72. *Coal* (splinty)	0	4		
73. Soft light blue metal	4	11		
74. Hard white freestone	3	8		
75. Soft blue metal	3	2		
76. Soft black metal	1	8		
77. Soft light blue do.	1	2		
78. Dark grey freestone	8	1		
79. Hard blue metal	2	7		
80. Dark blue do.	16	0		
81. Black do.	2	1		
82. *Coal*	0	1		
83. Black metal	0	2½		
84. Hard grey freestone	7	8		
85. Hard dark blue metal	4	3		
86. Soft dark blue do.	2	5		
87. Black metal	2	1		
88. *Coal*	0	6		
89. Soft light blue metal	0	2½		
90. Black metal and *Ironstone* band	1	10		
91. *Coal*	0	8		
92. Black dant	0	3		
93. *Coal*	0	11½		
94. Brown metal	0	8½		
95. *Coal*	1	1		
96. Soft dark blue metal	1	2		
97. *Coal*	0	2		
98. Soft dark blue metal	0	7		
99. Hard white freestone	6	5		
100. Soft light blue metal	1	3		
101. Hard grey freestone	3	6		
102. Hard dark blue metal	2	7		
103. Hard light do.	1	8		
104. Soft light do.	0	7		
105. *Coal* (splinty)	0	3		
106. Black metal	1	8		
107. Hard tills	5	8		
108. *Coal*	0	2½		
109. Hard dark blue metal	2	4		
110. *Coal*	0	4		
111. Dark blue metal	0	6		
112. *Coal*	0	5		
113. Hard tills	5	4		
114. Limestone	0	6		
115. Soft light blue metal	1	2		
116. Soft metal	1	0		
117. Hard freestone	0	5		
118. Soft blue metal	0	9		
119. Hard white freestone	10	3		
120. Hard blue metal	1	2		
121. Hard white freestone	3	3		
122. Hard blue metal	4	1		
123. Soft do.	1	1		
124. *Coal*	0	6		
125. Blue metal	0	4		
126. *Coal*	0	7		
127. Soft black metal	0	9		

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		Ft.	In.	Ft.	In.
128.	Hard white freestone	3	6		
129.	Dark blue metal	1	5		
130.	*Coal*	0	7		
131.	Soft light blue metal	1	7		
132.	Hard grey freestone	3	3		
133.	Dark blue metal	1	2		
134.	*Coal*	0	4		
135.	Soft dark blue metal	0	7		
136.	Soft light blue metal	6	8		
137.	Hard black do.	1	2		
138.	Light red freestone	4	6		
139.	Soft black metal	0	7		
140.	Dark red freestone	6	4		
141.	Hard white do.	0	7		
142.	Soft black metal	3	1		
143.	*Coal*	0	10		
144.	Soft dark blue metal	1	1		
145.	*Coal*	0	5½		
146.	Soft black metal	1	0		
147.	Dark blue do.	3	8		
148.	Dark red freestone	24	4		
149.	Light grey whin	1	0		
150.	Dark brown limestone	0	8		
151.	Soft black metal	0	1		
152.	Hard dun blue metal	1	5		
153.	Hard tills	2	5		
154.	*Coal*	0	2		
155.	Soft dark blue metal	2	0		
156.	Hard dun post	0	10		
157.	*Coal*	0	3		
158.	Soft black metal	0	2		
159.	*Coal*	0	3		
160.	Soft blue metal	0	6		
161.	Hard dun metal	3	6		
162.	*Coal*	0	8		
163.	Soft black metal	0	1		
164.	*Coal*	0	3		
165.	Soft light blue metal	4	9		
166.	Slaty blue metal	2	3		
167.	Hard freestone girdle	0	4		
168.	*Coal*	0	7		
169.	Limestone. Roof of Main Coal	1	2		

Section of Main Coal Seam.

	Ft.	In.			
Top Coal	2	10			
Band, grey stone	0	3	4	4	314 7
Ground Coal	1	3			
Depth to coal sill					662 11

Sunk below Main Coal for sump.

Blue metal	4	2		
Freestone band	0	5		
Hard dark blue metal	1	1		
Freestone	4	7		
Coal	0	8		
Soft dark blue metal	0	3		
Coal	0	8		
Hard light blue metal	0	3		
Freestone bands	0	4		
Soft light blue metal	0	7		
			13	0
Total depth			675	11

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The following are sections of the Main Seam as proved in two other pits on the Scremerston estate :—

Old Engine Pit.	Ft.	In.	*No. 16 Pit.*	Ft.	In.	Ft.	In.
Limestone - -	2	0					
Coal, coarse - -	1	6					
Grey metal stone -	0	6					
Coal, coarse - -	0	10					
Stone - - -	0	2½					
Rough stone - -	0	10½					
Scremerston Main Coal	4	3	*Top Coal* -	2	8	3	11
			Band - -	0	4		
			Ground Coal -	0	11		

The section of the Isabella Pit shows that the crop of the Main Coal must be close to the pit-mouth on the south. The change from the S.S.E. dip of about 10° to a N.E. dip of 30° to 40° is very sudden from this point, and one or two faults have been proved to exist. These will be noticed further on. The small pits to the coal in Piper's Quarry, near the south end of Spital, were said to be 6 fathoms deep, and so we are close to the crop. But further north nothing can be learned of it, or of the Bulman Seam below, as very little rock is exposed behind Spital, and nothing is seen on the shore opposite. Between Spital and the Carr Rock to the west we come upon a thick bed of rather soft massive sandstone, below which are traces of coals and several thin limestones interstratified with shales and sandstones, probably about the horizon of the Cooper Eye Coal. West of the Carr Rock we see shale with ironstone nodules and a coal-seam, 2 inches thick, lying on sandstone. All these beds dip E.N.E. at angles of about 35°, and it is almost certain that all the workable coals, with the exception perhaps of the Wester Coal, crop out to the east of the Carr Rock.

The sandstone of the Piper's Quarry is fine, hard, and white. Between this and Sea View is a sandstone quarry, in which about 40 feet of rock is seen dipping E.N.E. about 30°. It is thin-bedded with lenticular shale bands above, becoming massive below, and is fine in grain. The quarry is said to have yielded some fine specimens of fossil trees and also shells. Sandstone is visible in a quarry at Catchlaw Crag, which may be about this horizon.

The *Caldside* or *Fawcett Coal* has been worked from the sea all across the Scremerston Estate, having been drained by a level which starts from the coast near Redshin. It is in places a fair household coal, bituminous like the others, but not so good as the Scremerston Main Coal or the Cooper Eye Seam. It seems to have been used formerly for lime-burning to a great extent. Its average thickness is about 2 ft. 6 in., and it is said to crop out in the churchyard at Richardson Stead. At the Jack Tar Pit it was exceptionally thin, only 8 inches, and this thinning extends over an area about 300 yards broad, running in a direction N.N.W. from the Jack Tar Pit to the outcrop of the Seam.

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Robie's Coal is 1 ft. 5 in. thick in the Jack Tar Pit; it has been tried a little, but is not of much value. It may be seen east of Richardson Stead, in the cutting for the railway to Jack Tar Pit, where it lies between sandstones with the following section:—

	Ft.	In.
Sandstone.		
Coal with some shale	1	9
Shale mixed with coal	1	3
Fine sandstone.		

About 15 or 20 feet of fine sandstone is seen in the quarry below, and this sandstone has been extensively wrought in former times close to Richardson Stead. A very thick bed of sandstone, which comes above the coal, is visible in the railway-cutting, dipping S.S.E. from 7° to 10°.

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CHAPTER IV.—CARBONIFEROUS—*continued.*

Limestone Group, or Calcareous Division.

We shall describe the remainder of the area (the larger part of the map) under this head, and the description will be mainly that of the section on the coast, little being seen of the beds inland.

General Section of the Calcareous Division.

	Ft.	In.
Sandstone and shale with probably thin limestone and coals	about 100	0
Lickar Main Coal	2 to 3	0
Sandstone and shale, probably	50 to 60	0
Dryburn limestone	25	0
Probable *Coal* / Sandstone and shale	70	0
Thin limestone	2 to 3	0
Sandstone and shale	35 to 50	0
Sandbanks limestone (with shale)	27	0
Coal	0	6
Sandstone and shale	60	0
Acre limestone	20 or more.	
Probable *Coal* / Sandstone and shale	40	0
Acre Coal	1 to 1	3
Sandstone and shale	40	0
Thin limestone	5	0
Sandstone and shale	25	0
Eelwell Limestone, contorted	20	0
Sandstone and shale	20	0
Limestone	5	0
Sandstone and shale	10	0
Eelwell Coal	1	3
Sandstone and shale	45	0
Limestone. Seven Foot	8	0
Sandstone and shale	20	0
Limestone, blocky	6	0
Coal.		
Flaggy sandstones and shales	35	0
Limestone, impure yellow brown, in one bed	2	6
Shale and 5 or 6 inches of *Coal* below.		
(Small Fault.)		
Sandstones (two beds white and blocky, one flaggy) and shale	30	0
Limestone, grey, weathering brown, in four beds	6	6
Coal, a few inches.		
Sandstone (one white blocky bed) and shale	35	0
Limestone	3	6
Sandstone, flaggy	20	0
Shale	50	0
Oxford or Greenses Limestone	15	0
Sandstone with some shale and probably *Greenses Coal*	175	0
Sandstone and shale of *Redshin Cove*	50	0
Sandstone, thin bedded (some shale)	35	0
Sandstone, thin bedded and shale	9	0
Sandstone, massive red of Maidenkirk Brae	33	0

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	Ft.	In.
Sandstone red, and reddish sandy clay	23	0
Sandy shale and sandstone, very irregular	17	0
Blocky yellow limestone, lenticular	0 to 2	6
Sandstone massive, red, (*Redshin*) coarse at top	33	0
Shales about	6	0
Limestone with Encrinites and Productus	0	6
Sandstone and shale, red	30	0
Shale mostly. This contains bands of *Oil Shale* about one third from base	22	0
Limestone, dark, and impure	about 1	0
Limestone, impure, yellow, magnesian; fine grained	1	0
Sandstone and shale	11	0
Sandstone, thinly bedded and reddish, some shale and clay	34	0
Clayey shales and reddish sandstone	33	3
Shale *Coal* shaly, 12 to 15 inches Shale, 12 to 15 feet *Coal*, a few inches Ironstone	20	6
Sandstone, rather thinly bedded	17	0
Shale, fossiliferous in lower part	25	0
Woodend Limestone, blue and grey, with corals	8	6
Shale	5	0
Coal, a few inches.		
Stony clay seat, with plants	3	0
Lumpy grey and green nodular sandstone, perhaps calcareous in part	15	0
Sandstone, massive, some coarse (Hudshead and Pier Quarry.)	66	0
Coal, 1 to 3 inches, and some shale, calcareous ironstone nodules above, and irregular bits of coal.		
Sandstone, thinly bedded and irregular; passing up into shale and coal	35	0
Shale, dark grey with ironstone nodules	16	0
Dun Limestone, brownish yellow, impure, with *Productus* and Corals	5	0
Dun Limestone Coal, pretty good	1	6
Underclay (not well seen)		
Clayey shale and sandstone	8 to 10	0
Shales, grey and sandy, with some sandstone, about	40	0
Coal, bad, shaly, at level-mouth		9 to 10
Clayey sandstone seat.		
Sandstones and shales (not well seen).		

The total thickness down to the Dun Limestone is upwards of 1,500 feet.

Very little is known about the beds above the Dryburn Limestone in this area, so that the thicknesses given in this part of the section are uncertain. The Lickar Main Coal is said to have been worked long ago at Cheswick, but nothing is known of its thickness. From the number of old pits and dayfalls about Cheswick it would seem to have been fairly good. The workings were probably stopped by the Cat Inn Fault, which has a rather large throw down to the east. They were drained by a level which starts from the side of the little stream east of the

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village. The Lickar Main Coal is said to have been proved about the year 1870, in a pit 7 fathoms deep sunk in a field by the roadside opposite to Ancroft Tile-works. The sinking was through clay and quicksand, and the coal is said to have been about 4½ feet thick below quicksand. Another trial was made for the seam by a shaft sunk further west to the depth of 13 fathoms. Here, below clay and quicksand, rock was found in thin bands, and two seams of coal, one 26 inches the other 30 inches. These were supposed to lie above the Lickar Main Seam which was never reached. In the area to the south (110 S.E.) the Lickar Main Coal and other seams have been worked north of Lowick, where the general section of these seams is as follows :—

	Ft.	In.
Limestone	4	0
Coal	2	0
Freestone	6	0
Coal (Coarse Parrot)	2	6
Sagger clay—Metal	2	6
Freestone	3	4
Coal, rough	1	8
Freestone and shale	15	6
Lickar Main Coal	2	6
Freestone and shale	56	0
Dryburn Limestone.		

There are traces of old quarries on the east side of Cheswick which were probably for sandstone, as that rock forms most of the walls in the neighbourhood.

The Dryburn Limestone till lately could only be seen within this area in one or two bosses projecting through the sands on the shore east of Cheswick village, where the rock was seen to be much contorted. It was in 1885 being worked at a new quarry at Scremerston west of the links or sandhills, and a little way north of the Cheswick boundary, and nearly half-a-mile south-east of the Scremerston Lime-works.

The list of fossils collected at this new quarry will be found in the Appendix (p. 29.)

The beds here have a general south-easterly dip, but they must turn sharply round under the sandhills east of the quarry and strike to the south-east nearly along the shore-line to the bosses of limestone that are seen protruding through the sand at low-water, half-a-mile or so to the south-east of the new quarry. This is evident from the run of the beds below, which are seen at the Cheswick Black Rocks and along the line of low-water-mark to the eastward and south-eastward. The Dryburn Limestone is thickly covered with drift inland and cannot be traced. There are indications of old quarries in the fields between the Black Rocks and the village of Cheswick, in some of which the limestone may have been found A limestone, which is probably that of Dryburn, may be seen in a small quarry south-south-east of Ancroft Stead. At Cheswick Black Rocks we see most of

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the beds that come between the Dryburn Limestone and the next thin limestone. The following is the section :—

	Ft.	
Coarse, massive, false-bedded sandstone with large irregular concretions, seen for breadth of 200 feet, or more, probably	30	thick.
(Gap for breadth of 115 feet may be shale), say	15	„
Sandstone 120 feet wide—thin bedded, fine, about	20	„
(Gap of 10 yards—may be shale), say	5	„
Limestone, brown, passing down into fine hard calcareous sandstone	3	„

The last-mentioned bed may be seen continuously running for 700 or 800 yards along the line of low water. The dip increases from about 9° to as much as 15° towards the south, and so this thin bed comes nearer to the bosses of the Dryburn Limestone in that direction. The section, however, is incomplete above, and there may be some thickness of beds coming above the highest seen at the Cheswick Black Rocks, and the base of the Dryburn Limestone which is concealed under the sand. About 200 yards north of the Black Rocks we see the thin limestone striking to the north-east parallel to the beds of the new quarry in the Dryburn Limestone, and this strike continues for 200 yards out to the low-water line, beyond which there must be a sharp bend round to the south-east, or a fault.

There is a fairly continuous section northward along the shore as follows :—

	Ft.	In.
Brown limestone and calcareous grit with large concretionary encrinital patches	3 or 4	0
Hard sandstone, fine and blocky	5 or 6	0
Thin bedded sandstone, flaggy for 22 yards wide, with dip of 6°-9°, say, about	8	0
Bed of dark shaly sandstone with " date kernel " casts.		
Thin bedded flaggy sandstone for 22 yards, say	8	0
Shales and shaly sandstone, 55 feet wide	7	0
Gap, 15 feet wide, probably shale	2	0
Thick shales, 18 feet wide	2	6
Gap of 66 feet, shale seen in one place, probably all shale	8	0
Limestone and calcareous shale—the upper part of the Sandbanks Limestone—dipping E.S.E. 5°-10°.		

The Limestone just mentioned is seen three times along the shore, at Far Skerr, Middle Skerr, and Near Skerr, owing to rolls, or to a low anticlinal and a low synclinal. The E.S.E. dip of the Far Skerr continues inland to the quarries that lie south of the cottages, where, at the south end, the dip is 10°, and we see the following section :—

	Ft.
Shales.	
Grey calcareous shale passing into grey limestone	4 or 5
Grey shale	2½
Limestone grey, compact, several feet.	

There is a small section in what is believed to be this limestone 700 yards to the south-south-west in a small stream at the corner of a plantation. The dip is the same both in amount

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and direction. No other trace of this limestone is met with between Scremerston and Ancroft Steads; but east of the latter place is a good-sized old quarry which is said to have been in this limestone. The large quarries at Scremerston were in the shallow synclinal formed by this limestone. The older portions nearly worked out, on the northern side, dipped to the south-east like the Near Skerr, while the southern part, now visible, dips 2°-3° to the north-north-west and is a continuation of the Middle Skerr. The beds are covered by red clay which thickens to 10 or 12 feet southward. Towards the north end of the quarry from 12 to 15 feet of shale is seen above the limestone.

The following is given by Mr. Richardson* the manager of the limeworks, as the general section here :—

	Ft.	In.
Blaes and bands	10	0
Onput: Calcareous shale, full of fossils	6	0
Dunstone with 1 foot of limestone in centre (an impure limestone)	3	0
Limestone	10	6
Blaes (1 foot shelly, 3 feet tilly)	4	0
Limestone, not worked	4	0
Shale.		
Coal, which has been got out on the shore by the workpeople	0	6

Dr. J. Hardy has given the following analysis of the Scremerston Limestone† :—

Carbonate of lime	94·04
,, ,, magnesia	0·72
Protoxide of iron and alumina	0·60
Siliceous matter	3·00
Water	0·69
Organic matter and loss	0·95
	100·00

Several large specimens of *Orthoceras*, between 3 and 5 feet long, have been found in this quarry. A list of fossils collected by the Survey will be found in the Appendix (p. 29). The beds between the Sandbanks Limestone and the Acre Limestone are little seen, so that the thickness of 60 feet given for them in the general section is only approximate. In the bay, north-east of Philadelphia, there is a small section in sandstone and shale which dip north-north-east at 5°; and the upper beds of the series are seen on the shore east of the Scremerston Lime-kilns, in the low anticlinal between Middle Skerr and Far Skerr. The beds visible are mostly sandstone with concretions; some of the beds are calcareous, and there are numerous so called "worm-tracks." The coal which lies below the Sandbanks Limestone may be seen near the Old Kiln at high-water-mark. It is probable that a coal also exists some distance below the Dryburn Limestone, but it has not been seen within the area.

* Mr. Richardson also supplied me with accounts of various borings made in the neighbourhood for limestone.

† Proc. Berwick Nat. Club, vol. xiii., p. 77, 1891.

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The *Acre Limestone* which is called the *Dun Limestone* at Lowick, can only be seen in this district at the Saltpan Rocks, south-east of Sea House, where it forms a reef which may be reached at low-water spring-tides. It dips eastward about 12°, but the beds are bent into folds, and there is probably a coal below it. The limestone is light grey in colour. This and several other limestones have been proved, by trial-holes sunk through the Boulder Clay in the fields to the south-west of the Scremerston Quarry; but the limestone is not seen at the surface until we reach Ancroft Steads Quarry, just outside the limits of this area. It has there been extensively worked, and a large and interesting collection of fossils has been obtained from it.

The beds between this limestone and the Eelwell Limestone, as detailed in the general section, are also only to be seen at the Saltpan Rocks. The dip increases fast to the westward, so that at the thin limestone (5 ft.) it is as much as 20°, and at the *Eelwell Limestone* about 30°. The Acre Coal may be seen close to the shore. Dark clayey shale lies above it, and dark clay below. The coal is 12 or 15 inches thick, poor and sulphury. It has been worked at Ancroft Steads Quarry just beyond the southern edge of the map.

The *Eelwell Limestone*, dipping steeply eastward forms the sea-bank from Sea House to Saltpan How. It is here much contorted, and browned in places as if dolomitized, and it is also contorted in the large quarry to the southward. A sketch of some of the contortions seen on the coast is given by Mr. E. F. Boyd.* There are old quarries in this limestone just south of the railway, and it may be seen in the burn to the southward; between these two places the limestone is probably displaced by a fault which was proved to shift the Oxford Limestone. There is an old limestone-quarry south-east of Scremerston Farm which was probably in this bed; but beyond this it is not traceable because of the overlying drift. There are six limestones seen on the coast between the Eelwell and the Oxford, but they do not call for any more detailed notice than is given in the general section. Several of them are seen in the railway-cutting south of Scremerston Station, and nearly all of them in the burn to the southward; and after that we see them no more; but some small sections of the sandstones and shales associated with them are visible in the first burn north of Ancroft, and by the road-side between Ancroft and Nab Hill. The Eelwell Coal is the only one of the coals, in this part of the series, that seems to have been worked near Scremerston, and that has been worked only to a very small extent. It may be seen in the railway-cutting 700 yards south of Scremerston Station.

The *Oxford Limestone*, or *Greenses Limestone*, is the one that has been most worked in this district, and is the only one the

* *Trans. N. of Eng. Inst. Eng.*, vol. ix., p. 212.

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course of which can be traced with certainty across the area. It was formerly worked on the sea-coast north-west of Sea House, at Cargies Kiln, but only a small portion of the limestone can now be seen in the quarry, though it is visible on the shore at low-water, shifted by two small faults ranging east-north-east, which throw down to the south. Five other faults ranging between east-north-east and north-east, and all throwing down to the south, may be traced at low-water between Cargies Kiln and the Flagstaff near Sea House. The Oxford Limestone is just seen by the railway, 200 yards south of the station, and in the fields to the southward it was proved in several places by the Scremerston Lime Company, the trial holes of which showed that a considerable fault, throwing down on the north-east, shifts the course of the limestone. It is not seen in the burn to the south, but it has been proved near the burn on the north side, and it was cut in drains by the road-side north-east of Scremerston Farm. There are also old quarries in this limestone to the south-west between the Farm and the great South Road; and west of this the limestone, along with some of the beds above and below, was proved in draining. The fault which shifts the limestone here, and which passes east of Scremerston Hill, is a continuation of the one proved in the workings of the Jack Tar Pit. There is an old quarry in the Oxford Limestone on the east side of the fault, which must be very near it, and it would seem that the throw of the fault is greater here than that proved in the colliery; perhaps it is as much as 150 feet. The small parallel fault on the east side, which throws down the same way, was fairly clear in the draining operations. From Linkhamdean Quarry, west of the large fault, there is an uninterrupted series of quarries in the limestone past Oxford to the Allerdean Burn, on the west side of which the limestone is thrown down by a fault parallel to that of Scremerston Hill and about equal to it in amount. Most of the quarries are very old and filled with water, and little can be seen of the rock except in the quarry at Linkhamdean, though sections of the thick shale-bed, which lies above the limestone, are abundant.

Lists of fossils collected at Oxford and at Cargies Kiln on the coast will be found in the Appendix (p. 29). This limestone has also been worked in a large quarry west of Ancroft where it is apparently brought to the surface by a low anticlinal. The limestone here and at Oxford is said to be nearly 20 feet thick, and is made up of six different posts or beds which have received local names. The lowest is impure, and is not used for lime-burning; the posts above, which are worked, amount to 16 or 17 feet. A thin coal generally underlies this limestone, and a few fathoms lower down occurs the Greenses Coal which does not appear on the coast, but has been worked near the limestone-quarry west of Ancroft where it was 2 ft. 6 ins. thick.

The following is a rough section of a coal-pit by the road-side just at the edge of the area:—

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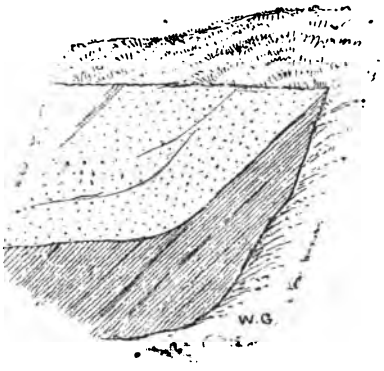
		Ft.	In.
Clay, 4 feet to 5 feet Tills, rubbly Tills, strong, blue and grey	about	54	0
Oxford limestone		20	0
Tills Sand *Coal*, 10 inches		9	0
Freestone bands		56	0
Limestone		2	0
Greenses Coal		2	6

The Greenses Coal is generally coarse, and fit only for lime-burning, and I know of no other place where it has been worked within the bounds of the present map. From the Dryburn Limestone down to the Oxford Limestone there are 12 or 13 bands of limestone at frequent intervals, but below the Oxford Limestone there is a mass of sandstones and shales about 500 feet thick, with only two or three thin and unimportant limestones. One of these, probably that which accompanies the Greenses Coal, is seen in the burn north-east of Scremerston Farm. The sandstones which are seen on the coast just below the Oxford Limestone, alternating with the shale, are, some of them, soft and red, very irregular and false-bedded; others are flaggy or blocky; and a thin shaly coal occurs at a place called Cuddy's Cove, but this would appear to be too low down for the Greenses Coal. In addition to the coast-section there is a good exposure of some of the beds between the Oxford and Woodend Limestones in the railway-cutting north of Scremerston Station. Several of the sandstone beds have a reddish tinge, and near the base they are massive, extremely irregular, and often coarse; and cases of erosion or local unconformity occur, of which the following seen south of Redshin, may be an example:—

Sketch of Local Erosion (or Fault?) South of Redshin.



A comparison of the sections on the coast and in the railway-cutting shows the inconstant character of some of the coals.

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For instance, in the cutting opposite Maiden Kirk Flat we see the following section:—

Thick sandstone of Redshin.
Coal, about 1 foot.
Encrinital limestone, few inches.
Shale, 4 or 5 feet.
Shale, with limestone-bands, 5 or 6 feet.
Hard white sandstone, several feet.

These beds on the coast at Redshin are somewhat different; the coal is absent, and below the massive red sandstone of Redshin we have:—

Shales, about 6 feet.
Limestone, with Encrinites and *Productus*, 6 inches.

A list of fossils collected here will be found in the Appendix (p. 29). At Maiden Kirk there is some evidence for a north-west fault; and one of the "troubles" proved in the old level of the Scremerston Main Seam points in this direction. But it is possible the appearances may be merely due to a slip, or to an irregularity of bedding. It is interesting to notice that about here the beds, both on the coast and in the railway-cutting, assume, in places, quite the character of the Lower Carboniferous or Tuedian Beds—the shales being reddish and greenish, and there are beds of red sandy clay or marl, and thin yellowish limestones like cement-stones. The red and greenish shales specially noticeable are those which accompany the thin bands of Oil Shale seen in the railway-cutting opposite Maiden Kirk where a bridge crosses the line, and on the coast near the Caldside Level Mouth north of Redshin. This Oil Shale contains small crustaceans and other remains.

Some distance above the Woodend Limestone occurs the Little Howgate Coal. In the coast-section previously described two coals are mentioned, one of which may be the Little Howgate, but both are poor. The Little Howgate Coal was much worked during the last century in the fields west of Scremerston Hill where it was said to be 3 feet thick and was wrought for lime-kilns. It has also been worked south of Jack Tar Pit, Scremerston Colliery, where there are traces of old pits. On the south side of the burn, between this and Scremerston Farm, we see another coal which may be that called the Muckle Howgate Seam. It lies below a grey nodular sandstone, is about 1 foot thick, soft and poor, and has a few inches of fire-clay below it.

This must be above the Oil Shale bed which was proved in a level on the north side of the burn, and it may be about the horizon of the coal previously noticed in the railway-cutting north of Scremerston Station, and also of that seen in the field just north of the road and nearly 200 yards west of the station, where the following section occurs:—

Coarse red sandstone.
Shale.
Coal, soft, 1 foot or more.
Under clay.

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The lowest group of the Calcareous Series, is formed by the *Woodend* and *Dun* Limestones, which however are only seen in this area along the coast—though both were sunk through at Jack Tar Pit. The Woodend Limestone was also proved in drains north of Scremerston Hill, where at the time the shifting of the bed there by the fault was very clear. As the beds occurring between these two limestones are shown both in the section of the Jack Tar Pit (p. 10) and in that of the coast, the reader may, by comparison of the two, become acquainted with the variations in thickness, &c., between the two points. Both limestones are coralline, that of Woodend especially, being in places almost made up of *Lithostrotion junceum*. This limestone is often light-coloured or grey, while the Dun Limestone is bluish, weathering to brown or dun colour, hence its name. Like all the other beds seen on the coast they make a bend nearly at right angles from the coast where they dip north of east at 30°–40°, round to about Scremerston Hill where the dip is nearly south, and about 10°. The coal which occurs immediately below the Dun Limestone is fairly good in quality and very constant, but it has not been worked in the area under description.

The Woodend and Dun Limestones can be traced a considerable distance along the shore to the northward at low-water, that of Woodend forming the rock known as the Bear's Head. The Dun Limestone can be traced to a spot opposite the Sea View Iron Works at the south end of Spital, where the dip is north-east, 30°–35°, and the limestone is shifted by several small faults, ranging north-north-east and throwing down on the east side.

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CHAPTER V.—FAULTS.

There are two sets of faults known in this area. The larger and more important of these range about north-west and south-east, nearly at right angles to the strike of the beds in the interior. The others ranging from east-north-east to north-east, are seen on the coast, and cross also nearly at right angles the strike of the beds, for near Sea House where the strike is north-north-west, the direction of the faults is between east-north-east and north-east; while near Spital where the strike is north-west the faults range north-north-east. The more important of those in the last-mentioned place are three in number, and each throws down to the east 4 or 5 yards. At Sea House some of the faults are a little larger than this, but all noticed throw down to the south-east. Two of these near the flagstaff have throws of 3 feet and 5 feet respectively, while farther north the throw of another fault is 4 or 5 feet. The next two faults are the largest here seen, being about 18 feet each. Beyond this there are several small faults near Cargies Plantation, the most northerly two having throws of about 15 feet.

The Allerdean and Scremerston Hill faults, which belong to the north-west set, have been mentioned in the description of the Oxford Limestone. They throw in opposite directions and both seem to increase in throw towards the south-east to as much as 150 feet. Two faults are marked as having been met with in driving the Scremerston Coal Level, the first throwing down north-east about 5 feet, and the second down south-west, 10 fathoms. According to Mr. Boyd, in the paper already referred to, the latter fault has a throw of 4½ fathoms. It perhaps was encountered in the Berwickhill Level—and may run to Maiden Kirk on the coast as already mentioned. Further west there was probably another "trouble" in the Scremerston Level, directed towards Borewell, as may be inferred from the sudden shifting of the level at one place. This seems to be in a line with the fault proved to shift the Oxford Limestone in the fields south of Scremerston Station, throwing it down to the north-east, and which is probably prolonged some distance to the south-east shifting the limestones above.

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CHAPTER VI.—GLACIAL DEPOSITS.

The low ground in the southern part of the area is thickly covered with a deposit of reddish glacial clay containing a few stones. Over the rest of the region this clay also occurs, but is very irregularly distributed and is of varying thickness. In such a low featureless district it is not easy to tell where the clay is or is not present, so that it must be understood there will be small patches of clay in places where none is marked on the Map, also small areas of bare rock in places coloured as drift. Very little glacial gravel or sand was observed. The only patches worth notice are some mounds of sand and gravel in the low ground south of Windmill Hill, but no sections were seen. Most of the stones in the clay are of local Carboniferous rocks; but in places boulders of porphyrite and Silurian grauwacke are fairly common, especially in the neighbourhood of the long drumlins in the south-west part of the area, north of Ancroft, Nab Hill and Scremerston Hill. The drift is probably thicker on these ridges which range from 10°–15° south of east.

The thicknesses of soil and clay proved in pit-sinkings are as follows:—Jack Tar Pit 4 feet, Isabella Pit 6 feet, New Winning 7 feet, Scremerston Old Engine Pit 23 feet (clay and broken stone); Pit near Ancroft Tile Works 18 feet, with quick-sand below. In the fields west of Scremerston Lime-works many holes were sunk through clay in trying for limestone—some of these were respectively 5, 7, 22, 27 and 40 feet deep in clay, and in the last no rock was reached. Drains 8 to 9 feet deep in clay on the north side of Cheswick did not touch rock.

This reddish clay was formerly used for making tiles—at Ancroft Tile Works, Bore Hole Tile Works, and at a clay-pit west of Tweedmouth Cemetery. Sections formerly visible in railway-cuttings are now covered with grass. The best section is at Scremerston Sandbanks Quarry, where the red clay thickens to 10 or 12 feet toward the south end and contains some pockets of sand; in one place a coarse dirty gravel, 5 or 6 feet thick, is seen below the red clay, resting on the limestone.

Glacial striæ have rarely been observed on rocks in this area; but some were visible in 1863 at the Scremerston Quarry, and they were described by Sir A. C. Ramsay,* as appears from the following extract. He stated that, "At and a little south of Berwick-on-Tweed, where the sea-cliffs are clear, or, when the Till has been removed, the surfaces of quarries of Carboniferous Limestone are found to be ice-polished and grooved, the striations point from 10° to 12° south of east." It is worth remarking that the direction of striæ on the rocks as noted above coincides with the directions of the ridges or drumlins in the south-west of the area.

* Physical Geology and Geography of Great Britain, Ed. 5, 1878, p. 385.

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CHAPTER VII.—POST GLACIAL DEPOSITS.

Alluvium.

The streams are small and there are no large spreads of alluvial soil except near Ancroft Stead at the junction of two burns, and in the flats near Windmill Hill and Goswick. A good deal of the Goswick Alluvium, however, seems to be of a mixed character—freshwater Alluvium brought down by the streams, having overspread an old marine Alluvium nearly cut off from the sea by sand-hills. Near Cheswick are several boggy or peaty flats which must once have been lakes, and it was probably in one of these that the skeleton of a Red Deer was found as described by Mr. J. S. Donaldson.* There is a basin-shaped depression, mostly on the east of the high road near Heatherytops, which contains a laminated reddish brown clay without stones. The clay is more conspicuously laminated below and varies from 3 or 4 feet to 12 feet thick, resting on stony clay or gravel. It has been much used for tile-making.

Raised Beaches.

The town of Spital stands on a Raised Beach, which, however, is much obscured in places by heaps of blown sand. Further south there is a narrow stretch of Raised Beach at Maidenkirk Flat near Cargies Plantation, but this is not far above high-water mark. It has been mentioned that the Goswick Flat is in part marine, being no doubt a continuation inland of the extensive tract laid bare at low water, known as Cheswick and Goswick Sands.

Blown Sand.

There is a small patch of this at the south end of Spital; and from Philadelphia southwards there is an almost continuous fringe of sand-hills along the coast, but the links are of no great width. The highest point the sand reaches, south of Cheswick Black Rocks, is 50 feet above Ordnance Datum.

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* Trans. Berwicksh. Nat. Club., vol. i. p. 91.

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APPENDIX.

I.—LISTS OF FOSSILS.

A.—*List of Fossils collected by the Geological Survey.*

Named by Mr. George Sharman.

The localities are numbered from above downwards, No. 1 being the highest Fossiliferous Limestone of the district. Nos. 1 to 11 inclusive, belong to the Calcareous Division; and No. 12 to the Carbonaceous Division of the Carboniferous rocks.

1. New Quarry Workings, nearly ½ mile S.E. of Scremerston Lime-works (Dryburn Limestone).
2. Scremerston Quarry and Lime-works (Sandbanks, or Low Dean Limestone).
3. Shore section, Middle Skerr, east of Scremerston Lime-works (Sandbanks Limestone).
4. *Shore section, near Sea House (Eelwell or Salt-pan-How Limestone).
5. 200 yards south of No. 4.
6. From a sandstone quarry a little south of Sea Houses.
7. Limestone, Shore section, between Sea Houses and Cargies Plantation (Oxford Limestone).
8. Oxford Quarry, 1½ mile north of Ancroft.
9. In the shale above the limestone of the same Quarry.
10. Shore section near Redshin Cove, 2 miles S.E. of Berwick (Thin limestone intermediate between the Oxford and the Woodend).
11. Limestone, Shore section, near Huds Head, 1 mile S.E. of Spital (Woodend Limestone).
12. Colliery, New Winning, near Deputy Row (probably from Limestone above Cooper Eye Seam).

PLANTÆ.

Calymmatotheca bifida, *L. & H.*, 6.
Lepidodendron, sp., 2.

FORAMINIFERA.

Endothyra Bowmani, *Phil.*, 9.
Textularia triticum ?, *Jones*, 9.
Valvulina palæotrochus, *Ehrenb.*, 9.

ACTINOZOA.

Alveolites depressa, *Flem.*, 4, 7, 8.
—— septosa, *Flem.*, 1.
Clisiophyllum ?, 11.
Cyathophyllum Murchisoni, *E. & H.*, 7, 8.
Cyclophyllum fungites, *Flem.*, 1.
Lithostrotion junceum, *Flem.*, 1, 2, 4, 10, 11.
—— Portlocki, *M. Edw.*, 4.
Lonsdaleia, sp., 4.
Zaphrentis, sp., 4, 8, 10.

* See also the lists of fossils in the Tate Collection at Alnwick, p. 31.

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ECHINODERMATA.

Archæocidaris Urei, *Flem.* (plate), 10.
—— (spine and plates), 9.
—— (spine), 8.
Crinoid stems, 2, 8, 9.
Poteriocrinus crassus, ***Mill***, 4, 8.
—— sp., 2, 10.

CRUSTACEA.

Griffithides, 5.
Beyrichia arcuata, *Bean.*, 12.
Ostracoda, 12.
Leperditia Okeni, ***Münst.***, 9.
Bairdia Hisingeri, ***Münst.***, 9.
—— plebeia ?, *Reuss*, 9

POLYZOA.

Diastopora megastoma, ***M'Coy***, 8.
Fenestella (fragment), 9.
Glauconome, sp., 10.
Rhabdomeson rhombifera ?, *Phil.*, 8.
Vincularia multangularis, *Portl.*, 10.

BRACHIOPODA.

Athyris ambigua, ? *Sby*, 2.
Chonetes, 2.
Discina nitida, *Phil.*, 2.
Orthis Michelini, *Leveillé*, 10.
Productus costatus, *Sow.*, 8.
—— giganteus, *Mart.*, 1, 2, 4, 7, 8, 10.
—— longispinus, *Sow.*, 2, 4.
—— semireticulatus, *Mart*, 1, 2, 5, 7.
Rhynchonella pleurodon, *Phil.* (fragment), 2.
Spirifera glabra, *Mart.*, 2.
—— trigonalis, *Mart.*, 1, 2, 4, 5, 7, 10.
Streptorhynchus crenistria, *Phil.*, 1, 2, 3.

MOLLUSCA.

Lamellibranchiata.

Aviculopecten semicircularis, ***M'Coy***, 2.
Axinus (Schizodus) ?, 12.
Edmondia sulcata, *Phil.*, 2.
Leptodomus ?, 12.
Modiola Macadami, ***Portl.***, 12.
Nucula undulata, *Phil.*, 2.
Pinna flexicostata, ***M'Coy***, 2.
Solemya primæva, *Phil.*, 2.

Gasteropoda.

Bellerophon decussata ?, *Flem.* (fragment), 2.
Loxonema, 9.
Pleurotomaria (fragment), 2.

Cephalopoda.

Nautilus, 3.
Orthoceras, 3.
—— (Actinoceras) giganteus, *Sow.*, 2.

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PISCES.

Fish scales and bones, 2, 10, 12.
Cladodus, 2.
Psammodus rugosus, *Ag.*, 10.
Megalichthys, 12.

B.—*List of Fossils in the Alnwick Museum, collected by the late George Tate.*

The species were named by Mr. R. Etheridge.

Carboniferous Fossils from Spital.

Orthis Michelini, *Léveillé.*
Productus punctatus, *Mart.*
Spirifera trigonalis var. bisulcata, *Sby.*
—— glabra, *Mart.*
Streptorhynchus crenistria, *Phil.*
Axinus (Schizodus) obliqua, *M'Coy.*
Pinna flexicostata, *M'Coy.*
Posidonomya Becheri, *Goldf.*
Cardiomorpha Egertoni, *M'Coy.*
Edmondia sulcata, *Phil.*
Leptodomus costellatus, *Brown.*
Nucula (Leda) undulata, *Phil.*
Sanguinolites irridinoides, *M'Coy.*
—— variabilis, *M'Coy.*
Solemya primæva, *Phil.*
Macrochilina acuta, *Sow.*
Naticopsis plicistria, *Phil.*

Carboniferous Fossils from Berwick.

Streptorhynchus crenistria, *Phil.*
Aviculopecten, *Sp.*
Pecten (Entolium) Sowerbyi, *M'Coy.*
Edmondia rudis, *M'Coy.*
Sanguinolites curtus ?, *M'Coy.*

The exact locality of these fossils from Berwick and Spital cannot be determined. They may have been taken from beds on several different horizons.

Carboniferous Fossils from Scremerston.

Productus latissimus, *Sow.*
Axinus (Schizodus) carbonarius, *Portl.*
Solemya primæva, *Phil.*
Orthoceras undulatum, *Sow.*

These may be from the Sandbanks Quarry.

Carboniferous Fossils from How Salt-Pans.

Actinocrinus globosus, *Phil.*
Productus cora, *D'Orb.*
Aviculopecten docens, *M'Coy.*
Pecten sub-elongatus, *M'Coy.*
Edmondia (Sanguinolites) arcuata, *Phil.*
—— —— oblonga, *Portl.*
—— rudis, *M'Coy.*
Sanguinolites variabilis, *M'Coy.*
Solemya primæva, *Phil.*
Streblopteria (Meleagrina) pulchella, *M'Coy.*
Dentalium priscum, *Goldf.*
Euomphalus Dionysii, *Goldf.*

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Loxonema tumida, *Phil.*
Nautilus bilobatus, *Sow.*
—— biangulatus, *Sow.*
Orthoceras cylindraceum, *Flem.*
—— goldfussianum, *De Kon.*

As this locality is more accurately specified, the above must be from the Eelwell Limestone (see also locality No. 4. p. 29).

I append some notices of fossils from the *Transactions of the Berwickshire Naturalists Club, Vol. IV.*

At p. 228 (1861) it is stated "Mr. Sanderson exhibited . . . . . *Gyracanthus obliquus*, a fish spine, from the shale of Scremerston, from the beds south of the Tweed, belonging to Mr. James Patterson. Besides many of the commoner forms there were large specimens of *Actinoceras giganteus* and *Pinna flexicostata*; and of the rare *Orthoceras cornu-vaccinum*."

At p. 335 (1862) mention is made of an important collection of fish-remains obtained by Mr. Patterson from the shales connected with the coal seams of the district; and a specimen of *Spirifer bisulcatus* is noted from a shale near Hud's Head, "showing distinctly the spiral coil which supported the fleshy arms."

II.—LIST OF CHIEF PUBLICATIONS ON THE GEOLOGY OF THE DISTRICT.

1831.

WINCH, N. J.—Remarks on the Geology of the Banks of the Tweed. *Trans. Nat. Hist. Soc., Northumberland, Durham, and Newcastle*, vol. i.; and 4to. Newcastle; and *Phil. Mag. and Ann., New Series*, vol. ix.

WOOD, NICHOLAS.—On the Geology of Parts of Northumberland and Cumberland. *Trans. Nat. Hist. Soc., Northumb., &c.*, vol. i. p. 302.

1835.

MILNE [Milne-Home], D.—On the Geology of Berwickshire. *Report Brit. Assoc.* for 1834, Sect. p. 624; and *Trans. Highland Soc.*, vol. xii. p. 169; and *Quart. Journ, Agric.*, vol. vi. p. 182. Published separately in 1837 as "A Geological Survey of Berwickshire."

1836.

DONALDSON, J. S.—Notice of the Skeleton of a Red Deer (*Cervus Elaphus*) found at Cheswick, North Durham. *Proc. Berwicksh. Nat. Field Club*, vol. i. No. 3, p. 91.

1838.

MILNE D.—On the Berwick and North Durham Coalfield. *Report Brit. Assoc.* for 1839, Sect. p. 76.

1861.

BOYD, E. F.—On a Part of the Carboniferous or Mountain Limestone Series of North Northumberland. *Trans. N. of Eng. Inst. Min. Eng.*, vol. ix. p. 185. Discussion in vol. xi. pp. 174, 196, (1862).

1867.

TATE, G.—Miscellanea Geologica. *Proc. Berw. Nat. Club.*, vol. v. p. 283.

1868.

BAILES, G.—Sections of Mountain Limestone Strata at Scremerston, North Northumberland, with a "Note on the Scremerston Sections," by G. TATE. *Proc. Berwick Nat. Field Club*, vol. v. No. 5. pp. 349–357.

TATE, G.—Nat. Hist. Trans of Northumberland and Durham, vol. ii. Chap. i. Geology.

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1884.

NORMAN, F. N. *Embedded Reptiles*, with special reference to the discovery of a Live Frog in the Carboniferous Limestone at Scremerston. *Proc. Berw. Nat. Club*, vol. x. p. 491

1888.

BROWN, M. W.—A Further Attempt for the Correlation of the Coal Seams of the Carboniferous Formation of the North of England, with some Notes on the Probable Duration of the Coalfield. *Trans. N. Eng. Inst. Min. Eng.*, vol. xxxvii. p. 3.

Lists of Works on the Geology of North Northumberland are also given in the Memoirs on Quarter-sheets 110 S.W. and 110 N.W.

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